TWO ABERRANT KARYOTYPES IN THE SAGEBRUSH LIZARD (*SCELOPORUS GRACIOSUS*): TRIPLOIDY AND A "SUPERNUMERARY" ODDITY

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ABSTRACT.—Widespread karyotypic sampling in the lizard *Sceloporus graciosus* Baird & Girard has confirmed previous reports of chromosomal monotypy. Most individuals throughout the range have a diploid karyotype of 2N=30 consisting of 12 biarmed macrochromosomes and 18 microchromosomes. A single female karyotyped from the vicinity of Riverside, California, was unmistakably triploid, showing 3N=45 with 18 macrochromosomes and 27 microchromosomes. This female appeared phenotypically normal but appeared reproductively incompetent. A male from Zion National Park, Utah, showed an extra bivalent in some diakinesis arrays, which apparently represents a supernumerary chromosome.

A major study is currently in progress to determine the population genetic structure of the chromosomally monotypic sagebrush lizard, *Sceloporus graciosus* Baird & Girard. In this study 112 individuals from seven western states (AZ, CA, CO, ID, NV, UT, WY) were karyotyped to confirm chromosomal monotypy, and all but two individuals showed the previously reported 2N=30 normal karyotype (Cole 1971, 1975a, Jackson and Hunsaker 1970). One showed a triploid karyotype, and another possessed an extra bivalent in diakinesis spreads. The former represents the third known case of unusual triploidy in a species of *Sceloporus*, and the latter may be an example of a supernumerary chromosome.

METHODS

Lizards were captured alive by noosing or by stunning with rubber bands. Karyotypes were prepared according to Baker et al. (1982) from testes, in the case of reproductively active males, or from bone marrow in the case of juveniles, females, or postreproductive males. Prior to karyotyping the lizards were injected with a yeast-sugar solution (Cole and Leavens, 1971) to increase the mitotic index. Treated suspensions of bone marrow or testes cells were dropped onto clean microscope slides and stained with a 6% Giemsa phosphate solution (Patton 1967). At least five metaphase spreads were scored on most individuals.

RESULTS

Of the 112 lizards we karyotyped, 110 showed the normal 2N=30 karyotype, which consisted of 12 metacentric or submetacentric macrochromosomes (12M) and 18 microchromosomes (18m) (Fig. 1A). Macrochromosome pair two in metaphase cells with elongate chromosomes frequently showed terminal satellites (see arrow Fig. 1A) similar to those reported by Cole (1971) for this species. One adult female showed a triploid karyotype, 3N=45, consisting of 18 meta- or submetacentric macrochromosomes, and 27 microchromosomes. (Fig. 1B).

Diakinesis arrays from testes of 90 reproductively active males almost always consisted of six macrochromosomal and nine microchromosomal bivalents (Fig. 1C). One adult male, however, showed one extra microchromosomal bivalent in seven of 44 cells examined (Fig. 1D). Seven other arrays showed the more typical nine microchromosomal bivalents, while the remaining 30 spreads were incomplete.

DISCUSSION

Karyological work done on S. *graciosus* includes 17 specimens examined by Cole (1971, 1975a) from Arizona, California, Colorado, New Mexico, and Utah, five specimens examined by Jackson and Hunsaker (1970) from California, and 112 specimens examined by us

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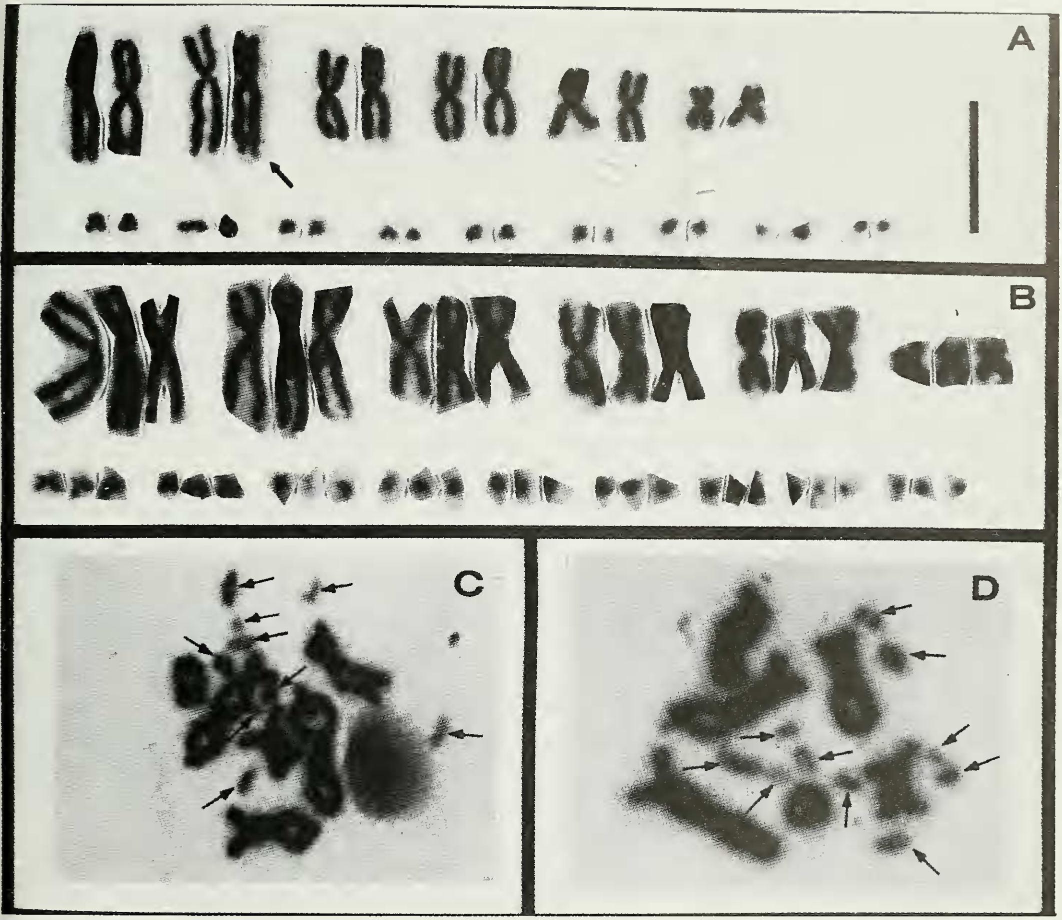

Fig. 1. Karyotypes of *Sceloporus graciosus*. Bar represents 10 μm for all karyotypes. A, Normal 2N=30 (12M + 18 m) karyotype with terminal satellites (see arrow) on pair two (juvenile, BYU 37620). B, Triploid 3N=45 (adult female, BYU 38201). C, Normal diakinesis array showing nine microchromosomal bivalents, (adult male, BYU 37975). D, Diakinesis array showing extra "bivalent" (adult male, BYU 37608).

from the above states as well as Idaho, Nevada, and Wyoming. Of 134 individuals karyotyped thus far, only two individuals with the anomalies illustrated above (Fig. 1B, 1D) deviate from the normal 2N=30, 12M + 18m pattern. Since both the anomalous individuals were single isolated cases within their respective population samples (the triploid was one of seven individuals karyotyped from San Bernardino County, California, and the individual with an extra chromosomal bivalent was one of seven specimens karyotyped from Zion National Park, Utah), it is likely that these cytotypes are not widespread.

Most reported cases of triploidy in lizards are associated with parthenogenetic populations or species that are thought to have originated by interspecific hybridization (Bickham 1984, Cole 1975b, 1984, Hall 1970). However, isolated cases of triploidy have been found in nonparthenogenetic lizard species. A single aberrant triploid individual was reported by Witten (1978) in the Australian agamid *Amphibolurus nobbi*. Additional cases of triploidy have been reported for two species of *Sceloporus*. From a sample of 1,300 lizards karyotyped, Hall (1973) scored four triploid individuals of the chromosomally variable *S. grammicus* complex. Three of these were males of three different chromosome "races" or cytotypes. The fourth, a female discovered in a hybrid zone between two cytotypes, possessed two chromosome sets from one parental cytotype and one from the other. The hybrid nature of this karyotype led Hall to suggest that this female may represent an incipient parthenogen. The second example in the genus *Sceloporus* was a triploid adult female of *S. occidentalis* reported by Cole (1983) from a sample of 16 individuals karyotyped from the Pine Valley Mountains of southwestern Utah. At this locality *S. occidentalis* occurs sympatrically with three other species of *Sceloporus*, but there was no evidence that interspecific hybridization was involved in the production of this triploid. Furthermore, comparative study of the reproductive tracts of other adult *S. graciosus* collected the same day indicated that the triploid was sterile, having small unplaited oviducts compared to the broadly plaited oviducts and yolked follicles of the other females.

The triploid example we report herein appears also to be an aberrant individual of nonhybrid origin, as all three haploid sets are morphologically typical of *S. graciosus* (Fig. 1B). This individual appeared to be a phenotypically normal adult female. The range of the four scale counts plus body length taken from all females collected from the San Bernardino County locality (N=5) are as follows (triploid value in parentheses): (1) scales around midbody, 50-61 (50); (2) dorsal scale count, 48-53 (50); (3) total fourth toe lamellae, 46-50, (50); (4) total supraoculars, 13-15 (14), and (5) (snout vent length, 56-60 mm (56). A noticeable difference was observed, however, in the reproductive condition of these five females. Whereas the four diploids possessed visible paired oviducts and either a shelled egg (in the case of one female) or small clusters of yolked eggs, the triploid uniquely possessed massive fat reserves and lacked visible paired ovaries and oviducts. We interpret this as sterility in the triploid female.

We suggest that these three isolated instances of aberrant triploid individuals (in *Sceloporus*) be interpreted simply as reproductive accidents (the fusion of a reduced with an unreduced gamete), not as incipient parthenogenesis, unless there is clear evidence of reproductive viability and the thelytokous production of all-female offspring.

The male who possessed an extra bivalent in some of its diakinesis arrays is more difficult to interpret, as there are no metaphase spreads or secondary spermatocytes available for this individual. The simplest explanation is that this extra element represents a single supernumerary or B-chromosome. It might also represent an extra microchromosomal bivalent, although the resolution on our slides does not permit this distinction to be made. The fact that not all cells possessed this extra element suggests that, if it is a B-chromosome or extra bivalent, it is not being distributed to all cells after mitotic division. We stress the very tentative nature of our interpretation and recognize the need for additional meiotic and C-band studies (see Patton, 1977, for a recent example with rodents).

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LITERATURE CITED

BAKER, R. J., M. W. HAIDUK, L. W. ROBBINS, A. CADENA, AND B F. KOOP. 1982. Chromosomal studies of the Sout American bats and their implications. Spec. Pub. Py matuning Lab. Ecol. 6: 303–327.

BICKHAM, J. W. 1984. Patterns and modes of chromosoma evolution in reptiles. Pages 13–40 *in* A. K. Sharma and A. Sharma, eds., Chromosome evolution in eu karyotic groups. CRC Press, Inc., Boca Raton, Flor ida.

COLE, C. J 1971. Karyotypes of the five monotypic specie groups of the lizards in the genus *Sceloporus*. Amer Mus. Nov. 2450: 1–17.

———. 1975a. Karyotype and systematic status of the san dune lizard (*Sceloporus graciosus arenicolus*) of th American southwest. Herpetologica 31: 288–293.

———. 1975b. Evolution of parthenogenic species of reptiles Pages 340–355 *in* R. Reinboth, ed., Intersexuality i the animal kingdom. Springer-Verlag, New York.

———. 1983. Specific status of the North American fenc lizards, *Sceloporus undulatus* and *Sceloporus occi dentalis*, with comments on chromosome variation Amer. Mus. Nov. 2768: 1–13.

———. 1984. Unisexual lizards. Sci. Amer. 250: 94–100.

COLE, C. J., AND C. R. LEAVENS. 1971. Chromosome prepara tions of amphibians and reptiles: an improved tech nique. Herp. Rev. 3(6) T-102.

HALL, W. P. 1970. Three possible cases of parthenogenesis in lizards (Agamidae, Chamaeleontidae, Gekkonidae). Experientia 26: 1271–1272.

———. 1973. Comparative population cytogenetics, speciation, and evolution of the iguanid lizard genus *Sceloporus*. Unpublished dissertation, Harvard University, Cambridge.

JACKSON, L., AND D. HUNSAKER. 1970. Chromosome morphology of sceloporine lizards (*Sceloporus occidentalis* and *S. graciosus*). Experientia 26: 198–199.

PATTON, J L. 1967. Chromosome studies of certain pocket mice, genus *Perognathus* (Rodentia: Heteromyidae). J. Mammal. 48: 27–37.

———. 1977. B-chromosome systems in the pocket mouse, *Perognathus baileyi*: meiosis and C-band studies. Chromosoma 60: 1–14.

WITTEN, G. J 1978. A triploid male individual *Amphibolurus nobbi nobbi* (Witten (Lacertilia: Agamidae)). Aust. J. Zool. 19: 305–308.